



**Fermilab**

**Closeout Presentations**

**Director's CD-2/3a Review**

**of**

**the MINERvA Project**

**August 1-3, 2006**

8/3/2006

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## **Executive Summary**

### **Technical**

The objective of the Main INjector ExpeRiment v-A (MINERvA) project is the fabrication of a high resolution neutrino detector capable of distinguishing explicit final states in the energy range of 0.5 to 3.0 GeV and measuring their neutrino cross-sections. It is a “fully active” detector with scintillator planes interspersed with nuclear targets in the forward sector surrounded by electromagnetic and hadron calorimeters comprised of Pb and Fe sheets respectively interspersed once again with scintillator bars.

A draft Technical Design Report (TDR) has been prepared which describes the design of MINERvA at the preliminary design level. This is the appropriate technical basis to support a baseline cost and schedule. An extensive R&D program has been underway and several prototypes have been completed. A vertical slice test (VST) shows promising results. A tracking prototype (TP) is planned which will firm up remaining uncertainties. Detailed plans for nine “custom factories” have been developed and form the basis for many of the labor cost estimates.

### **Cost**

A detailed work breakdown structure (WBS) has been prepared inclusive of the work to realize the scope of MINERvA. A WBS Dictionary describes in some detail what comprises each WBS element. A detailed basis of estimate (BOE) has been prepared to support the cost estimate. On the basis of specific “drill down” exercises in breakout sessions, the estimate is judged to be complete, documented, reviewable, and credible. There were a few errors identified and in some instances the estimate is felt to be high. The contingency assignments, averaging 34%, are judged to be reasonable for this stage of the project. The TPC submitted by the project to be considered as the baseline is \$16.8M comprised of \$10.8M MIE (major item of equipment) funding type and \$6.0M R&D.

### **Schedule**

The schedule for MINERvA is displayed in an ~1000 line MS Project file. In addition to durations for each activity, the BOE for M&S and labor, and other identifiers are included. The project has used this information for resource loading the schedule and developing manpower, cost, and obligation profiles. The target project complete date of April 2010 has five months float to the CD-4 date of September 2010. For the rather straightforward design and technology here this schedule is felt to be reasonable.

### **Management**

The MINERvA project organization draws on the MINERvA Collaboration comprised of Fermilab, JLab, and several universities. The Collaboration Spokespersons, Kevin McFarland, University of Rochester and Jorge Morfin, Fermilab play key roles in

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determining the technical direction of the project. A project office has been established and populated and Level 2 Managers have been named. The complete suite of CD-2 required documentation has been prepared. Final procurement packages for the long lead procurements must be developed for the Lehman DOE CD-2/3a Review. Overall from the Management perspective, MINERvA is close to being ready for a DOE Lehman CD-2/3a Review.

## **1.0 Introduction**

A Director's CD-2/3a Review of the MINERvA Project was held on August 1-3, 2006. The charge included a list of topics to be addressed as part of the review. The assessment of the Review Committee is documented in the body of this closeout presentation.

Each section in the closeout presentation is generally organized by Findings, Comments and Recommendations. Findings are statements of fact that summarize noteworthy information presented during the review. The Comments are judgment statements about the facts presented during the review and are based on reviewers' experience and expertise. The comments are to be evaluated by the project team and actions taken as deemed appropriate. Recommendations are statements of actions that should be addressed by the project team. A response to recommendation(s) is expected and actions taken will begin to be reported by the project within two months from the review closeout during the MINERvA Project Management Group (MPG) Meetings with a complete set of responses to be provided at the next Director's Review.

## **2.0 Technical**

### **2.1 Science**

Primary Writer: Jon Urheim

Contributor: Jianming Qian

#### **Findings**

- The collaboration has presented a compelling description of the physics aims of MINERvA in the TDR. It consists of a brief summary listing the physics topics, followed by a detailed description of each topic and some discussion of MINERvA's capabilities on the corresponding measurements.
- Specifications for detector performance based on physics considerations have been shown in the presentations at this review.
- The MINERvA run plan envisions one year of running with the NuMI 'low' energy (LE) beam, parasitic with MINOS, and three years of 'semi-medium' energy (sME) beam running, parasitic with NOvA. The component of the physics program that aims at providing engineering measurements for the present and future neutrino oscillation experiments will benefit from collection of data with the LE beam. The project schedule specifies completion of detector construction at the beginning of FY2010, which currently is envisioned by the laboratory as a shutdown year, after which NOvA will begin running with the sME beam. To achieve the current project schedule, forward funding of detector components on the critical path (with resources provided by University of Rochester) has been necessitated.
- A new addition to the R&D phase of the experiment is the 40-plane (20-frame) tracking prototype. The direct role of this device in physics measurements and its capabilities were not discussed.

#### **Comments**

- The MINERvA Collaboration should be commended for its detailed studies of the main physics topics within its scope. The brevity of the summary section in the TDR coupled with the lengthy description of each physics topic make it challenging for the reader to quickly extract a crisp understanding of MINERvA's potential contributions. Some key generic experimental characteristics have not been shown – for example  $\mu/\pi/p$  separation capability as a function of momentum. For most physics topics, considerable experimental detail is given. For others, although the physics goals are stated, little description of experimental detail (expected backgrounds, systematic uncertainties, etc) is included, making it difficult to evaluate the experiment's capabilities for those topics.



- The specifications for detector performance set by the physics goals were well-reasoned, and supported by realistic simulations in a number of cases. These specifications and justifications are not clearly summarized in the current version of the TDR, although some appear in scattered sections (for example, the requirement set by coherent pion production detection on energy and angular resolution).
- It is not clear how the MINERvA run plan will fit in with the actual schedule of the laboratory with regard to operating NuMI in the LE configuration.
- It is not clear whether the tracking prototype will include physics measurements in its function. Since it represents a 20% scale version of the MINERvA detector, it may have some capabilities in this regard.

### **Recommendations**

1. Continue to refine the ‘Physics Drivers’ sections (chapter 2) of the TDR. In addition, MINERvA’s capabilities and the requirements on the detector from physics drivers should be clearly summarized in an appropriate section, possibly the introduction, but certainly where the detector design concept is introduced. Generic detector performance characteristics, such as proton identification efficiency and purity (or  $\mu/\pi$  misidentification probability) as a function of momentum and angle, should be shown.
2. Quantify further the impact of a potential loss of LE running. How do MINERvA’s capabilities in the 0-1, 1-2 and 2-3 GeV ranges compare between data taken with the LE and sME beams, in terms of: (1) rates for processes of interest, (2) NC backgrounds to inclusive and exclusive CC processes, (3) other backgrounds from CC interactions from higher energy neutrinos that feed down to low reconstructed energies and (4) the study of NC interactions of low-energy neutrinos as might be relevant for MINOS, for example. Describe further the capabilities for untangling intranuclear rescattering effects by playing off data from the two beams.
3. Investigate, internally and with laboratory management, strategies for enabling collection of LE data by MINERvA prior to the shutdown scheduled for FY2010. If the tracking prototype is a part of one strategy for this, please clarify this strategy. Additional strategies for accelerating detector construction should be considered.

## **2.2 Scintillator Extrusions, WLS Fiber and Clear Fiber Cables (WBS 1, 2 and 4)**

Primary Writer: Jianming Qian

Contributors: Jon Urheim

### **Findings**

- The MINERvA Collaboration presented the detailed design of a fine-segmented detector for studying low and intermediate energy neutrino interactions. The detector, consisting of inner and outer detectors, is to be constructed from extruded scintillating strips embedded with wavelength-shifting (WLS) fibers. Clear fibers are connected to WLS fibers through optical connectors to transport light to multi-anode PMTs for readout. The total number of readout channels is 30,272.
- The Collaboration also presented detailed procurement plans, cost estimates and construction schedules. The scintillating strips are to be fabricated at the FNAL/NICADD extrusion facility while both WLS and clear fibers are to be purchased from Kuraray. The inner detector uses scintillating strips with triangular cross section of dimension 33mmx17mm while the outer detector uses strips with rectangular cross section of dimension 15mmx19mm. Both WLS and clear fibers will have diameter of 1.2mm. Strips are formed into layers. The light-sharing between two neighboring triangular strips provides significant benefits for position measurements.
- Extensive R&D has been done to optimize the detector design and to characterize its performance. R&D for scintillating extrusion is on going and is expected to complete this fall. Kuraray Y-11 (175 ppm) fiber has been chosen to be the WLS fiber and Kuraray S-35 fiber is selected as the clear fiber. The attenuation length for the clear fiber is found to be greater than 6m. Optical connectors designed by DDK for CDF upgrade has been found to meet MINERvA's need and has been adapted with small modifications. Light transmission efficiency through the connector is measured to be ~70% without optical grease. A relative increase of 16% per connection for an overall transmission efficiency of ~95% is observed with grease and no-change is found after two months.
- Results from vertical slice tests of setups that are slightly different from the final configuration have been scaled to estimate light yield of the final configuration. With optical grease for connectors, a yield of 22.8 photoelectrons (pe) per scintillator layer is expected, exceeding the minimum 13.2 pe/layer required to meet the detector's physics goal. The non-uniformity in response has been estimated to be around 15%, dominated by that of PMT. With expected 22.8 pe/layer, there appears to be enough safety margin.

- Various quality control techniques/processes have been developed and tested. Scintillators and WLS fibers are tested using radioactive sources while clear fibers are characterized using light.
- Most recommendations from the previous CD-1 review committee have been implemented. A few of them are currently being addressed.

### **Comments:**

- The MINERvA detector design is based on proven technologies that have been used in several other experiments such as D0, CDF, MINOS and CMS. There does not seem to be any technical show-stoppers.
- The Collaboration has made impressive progress in optimizing and finalizing detector design and in characterizing expected detector performances.
- The collaboration plans to use grease for optical connectors to increase light yield. Though no change has been observed in light transmission after two months, its long-term stability remains to be verified.
- Though none of the WBS covered by this report is on the critical path, their schedules nevertheless need to be closely monitored. Any delay in scintillator extrusion or clear fiber production for example will have domino effects on the entire project.
- Cost estimates and construction schedule are based on quotes from vendors and extensive prior experiences. The estimate for WBS 1.3.1.2 appears to duplicate those of WBS 1.3.1.3 and 1.3.1.4.
- It will be helpful for future reviews for the Collaboration to outline a list of cost changes with respect to previous cost estimates for each L2 WBS task. This will help reviewers as well as L2 managers tremendously.
- We are impressed with the expertise and knowledge of the critical personnel for these WBS elements. We thank them for their patience for answering our questions.

### **Recommendations**

4. The Collaboration should complete extrusion R&D as soon as possible. The one-week test extrusion run recommended by the CD-1 review committee should be performed to gain valuable experience for production and to verify extrusion rate and quality.
5. Where they don't exist already, detailed quality control procedure/techniques should be established for production. In particular, an absolute yield measurement for WLS fibers should be developed.

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6. The expected detector performance (light yield, response uniformity, position resolution etc.) should be validated with the final detector configuration. This will also allow for the exercise of the full detector chain.
7. Timely procurement of WLS and clear fibers from Kuraray is a concern given the expected large order from the NOvA experiment, potentially on the same time scale. The Collaboration should work with the laboratory to mitigate this concern through for example forward funding or coordination with NOvA.

## **2.3 Plane Assembly, Outer Detector Frame, Absorbers, Stand and Module Assembly (WBS 3, 8 and 9)**

Primary Writer: Mike Crisler

Contributor: Joe Howell

### **WBS 3 – Scintillator Plane Assembly**

#### **Findings**

- The final detector scope and requirements of the task have been stable since the December 2005 Director's review.
- Tasks for constructing a 20 Module tracking prototype have been added to the R&D portion of the project.
- A full ID plane prototype has been constructed at William and Mary using first or second iterations of the expected production tooling and with the same labor resources that will be used for production.
- Cost information has been transferred to MS project and is supported by basis of estimate documentation.

#### **Comments**

- Considerable progress has been made in the design and project planning since the December 2005 Director's review.
- Coordination with WBS 8 and 9 is very good.
- All recommendations from the previous review have been well addressed.

## **WBS 8 – Frame, Absorbers and Stand**

### **Findings**

- The final detector scope and requirements of the task have been stable since the December 2005 Director's review.
- Tasks for constructing a 20 Module tracking prototype have been added to the R&D portion of the project.
- Designs of the steel detector elements are very mature.
- The nuclear target configurations have been specified and preliminary designs have been developed.
- The effect on steel flatness of the fabrication of slots in the OD wedges is uncertain at this time. Additional fabrication work to flatten the OD wedges is currently covered by the contingency assigned to the task.
- Cost information has been transferred to MS project and is supported by basis of estimate documentation.

### **Comments**

- Considerable progress has been made in the design and project planning since the December 2005 Director's review.
- Coordination with WBS 3 and 9 is very good.
- All recommendations from the previous review have been well addressed.

## **WBS 9 – Module and Veto Wall Assembly**

### **Findings**

- The final detector scope and requirements of the task have been stable since the December 2005 Director's review.
- Tasks for constructing a 20 Module tracking prototype have been added to the R&D portion of the project.
- Extensive assembly testing has been conducted with ½ scale models of all major components.
- Cost information has been transferred to MS project and is supported by basis of estimate documentation.
- The need for Fermilab welding resources for module assembly has been eliminated by design changes.
- Workaround scenarios have been developed that decouple module assembly from frame assembly and make the assembly task relatively insensitive to fluctuations in Fermilab resources.
- The M&S portion of the Veto wall has a large contingency at this time due to uncertainty about the quality of the scintillator material, which is planned to be recycled from a previous experiment. Tests are underway to determine the usability of the material to be recycled.

### **Comments**

- Considerable progress has been made in the design and project planning since the December 2005 Director's review.
- Coordination with WBS 3 and 8 is very good.
- All recommendations from the previous review have been well addressed.

### **Recommendations for WBS 3, 8 and 9**

8. Include something in the project management plan that succinctly describes the management of design interfaces that is in place now.

## **2.4 PMTs and PMT Boxes (WBS 5 and 6)**

Primary Writer: Mike Lindgren

Contributor: Hogan Nguyen

### **WBS 5 – PMT Boxes**

#### **Findings**

- The MINERvA PMTs are housed in individual steel boxes which provide
  - light-tight mechanical protection
  - shielding from magnetic fields
  - Connections to optical fibers and the Light Injection (LI) System
  - Connection to the electronics front-end boards.
- There will be 110 boxes constructed at two sites, Rutgers, and Tufts, for the tracking prototype.
- There will be 550 boxes constructed at the same two sites for the production detector.
- A light injection system using 24 LED's and optical fiber delivery of light to the PMT boxes will be used to monitor the PMT gain stability and to provide corrections for the PMT gain drifts. The LED light will be monitored by a PIN diode.

#### **Comments**

- Near final prototypes of the PMT box have been built, and the design should be able to meet the requirements. The construction appears to be straightforward and low-risk, and the steps involved and costs are well documented and reasonable.
- The Light Injection system design as presented should be adequate for monitoring overall gain measurements, but the project needs to provide written specifications that detail the performance required, including any timing requirements.
- The schedule was well developed and mostly complete, reflecting substantial work by the project since the last review. There are still places where it should be scrubbed, and the BOE augmented with further quotes from vendors.



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- Box production is not rapid, but the leaders have well understood plans for mitigating the effects of delays in delivery of many of the parts that go into making them. Opportunities to advance the schedules should be investigated.

### **Recommendations**

9. Develop a full specification for the Light Injection system and get a prototype built and tested.
10. Coordinate with WBS 7 to make sure the elimination of the FESB's has no effect on the box design or schedule.

## **WBS 6 – PMT Procurement and Testing**

### **Findings**

- 600 Hamamatsu 64 channel H8804MOD-2 MAPMT's will be purchased and tested at JMU. The testing will be done in two sets. The first set is 100 tubes for the tracking prototype, followed by the 500 production tubes.
- No MAPMT testing results were shown.
- The MAPMT test stand will be built at four locations and used at a fifth.
- This WBS was presented as the project critical path.

### **Comments**

- Building the test stand at four locations and using it at a fifth will require good coordination and integration to be successful. The development of the software far from where it will be used is of some concern, so attention should be paid to documentation and support.
- The MAPMTs are well understood and reliable components that should present very low technical risk in the project. Their testing should not be allowed to drive the project critical path, especially if tests on the first set of tubes indicate that extensive testing does not add sufficient value.

### **Recommendations**

11. Correct the labor estimate error in the RLS for receiving MAPMTs (\$60k)
12. Consider developing a plan for forward funding to advance MAPMT purchases scheduled for FY2009
13. Do preliminary tests of a sample of MAPMTs and have results prepared for discussion at a CD-2/3a review.

## 2.5 Electronics and DAQ (WBS 7)

Primary Writer: Hogan Nguyen

Contributor: Stu Fuess

### Findings

- The FE electronics performance requirement is well-specified, and is justified by physics requirements. Notable performance requirements are on the threshold ( $<0.3$  PE), the dynamic range (350 PE), and the time resolution (3 nsec).
- The FE ADC electronics is based on the D0 Trip-t chip.
- A significant change from the CD1 review is that each PMT pixel channel is now digitized by a 3-range ADC, instead of a 2-range ADC.
- There are twelve Level 4, four Level 3, and one Level 2 milestones associated with WBS 7.
- A review of DAQ preparation is scheduled for 12/01/06.
- DAQ prototype hardware procurements listed as \$100,000 with 10% contingency; DAQ production hardware procurements listed as \$40,417 with 20% contingency.
- The rollups of the costs in the MS Project schedule match the presented tables with costs at Level 2.

### Comments

- The collaboration has made good technical progress in prototyping the electronics, particularly on the FEB and CROC boards. The current FEB design incorporates the FESB functionality, thereby eliminating the need for a separate FESB.
- The estimated duration for electronics acquisition and fabrication is reasonable. However we find that the costs and BOE can be improved. In particular, the cost estimate is too high for the off-the-shelf items such as the LV (~\$260/channel). The estimate for FEB cost should be taken from actual experience with prototype, instead of physicists estimate. We think that the cost estimates will be lower for the electronics boards, and significantly lower for the LV.
- The DAQ/Electronics presentation lacked detailed info on DAQ components (including software) and schedule for reviewer. The TDR would benefit from a DAQ overview. The breakout presentation clarified DAQ structure and plans.

- The technical plan for the DAQ seems appropriate to the complexity of the experiment; the sequence, timing, costs, and effort seem reasonable. The schedule has appropriate granularity of tasks and number of milestones, but lacks sufficient supporting information in the BOE.
- Software tasks, for example 7.1.1.2 "Develop VME interface software" (4w) and 7.1.3.3 "Write Prototype DAQ software" (16w) have no BOE info justifying the duration of the task and level of effort. A number of similar DAQ tasks lack any, or sufficiently descriptive, BOE information. For example, the DAQ and Slow Control Software tasks, 7.2.1.1.1 (16w) and 7.2.1.1.2 (24w) lack a BOE, and 7.2.1.1.3 (16w) references a document with no relevant information.
- Several DAQ tasks reference DocDB note #260 for the BOE. This document lacks specifications or quotes for DAQ hardware sufficient to justify the assigned costs and contingencies, and supplies no information on software development.
- The DAQ hardware M&S costs in document #260 are listed by UID, but do not match the costs entered for tasks 7.1.1.1 and 7.2.1.2.1.

### **Recommendations**

14. The collaboration should continue progress on prototyping, and aim towards a full-system test of one or several PMTs with its complement of HV base and FEB.
15. For the Lehman CD-2/3a review, the technical design, cost, and schedule should reflect the current progress made in the design of the FEB. In the current design, the FESB functionality has been incorporated into the FEB, thereby eliminating the need for a separate FESB board. This will be a significant improvement to the electronics cost and schedule.
16. The costs and BOE for the electronics should be scrubbed (see comments above).
17. Include slides showing the planned evolution of DAQ "bottom up" development and listing Minerva-specific software in future WBS 7 presentations. The slides presented in the breakout session were fine for this purpose. Incorporate the same items into the TDR.
18. Complete the BOE for DAQ tasks; scrub BOEs prior to CD-2/3a review.

### **3.0 Project Management (WBS 10)**

#### **3.1 Cost**

Primary Writer: Marc Kaducak

Contributors: Ken Domann, Dean Hoffer

#### **Findings**

- The team presented to the committee their cost estimates for each subtask and a level 2 WBS rollup. Presentations were given from each subtask based on their own work scope. The total project cost estimate including contingencies, escalation, and burdens is \$16.8M, not including activities funded by an NSF MRI (Major Research Instrument) grant, and not including installation and commissioning at Fermilab. Total MIE is \$10.8M and Total OPC (R&D) is \$6.0M.
- The NSF MRI grant amount is \$0.77M, of which \$0.28M is in the current Minerva project scope for the Light Injector System (WBS 5.3.5), Nuclear Target Materials (WBS 8.3.2), and the Mapper (WBS 9.1.3.5). The remainder is planned for funding scope additions including a cryogenic Helium target and a testbeam detector.
- The project presented Basis of Estimate(BOE) documents in a binder. BOE documents are also available in the DocDB system online.
- The amount requested for long lead procurements to be made in 2007 is \$167k for WLS Fiber for ½ of the project, \$159k for clear fiber for the entire project, \$52.5k for optical connectors for the entire project, and \$5k for Noryl plastic for PMT holders for the entire project. These items will be under review for CD-3a.
- An additional overhead factor of 33% was applied to all Fermilab labor, contributing to \$1.4M of the increase from the prior estimate presented in Dec.2005.

#### **Comments**

- The committee was impressed with the level of detail in the cost estimate and appreciates the amount of effort required to develop it.
- The committee felt that the cost estimate was complete, well documented, reviewable, and credible (except DAQ).
- The costs presented by team were in general very consistent between the MSP files, rollups, and L2 presentations.

- Methods for determining contingencies and presenting basis of estimate were systematic and the materials were very well organized. The team was quickly able to navigate to backup materials upon request.
- The committee found the following concerns in the process of drilling down through the WBS:
  - WBS 6.3.1.4 through 6.3.1.15: There is approximately \$60k labor cost in these sections for receiving PMTs. The project acknowledged that this was an error.
  - The BOEs for the FE and CROC are listed as Physicist Estimates and could be refined since there is sufficient experience in electronics fabrication on the project team.
  - The Front End Support Boards (FESB) will likely be eliminated from the scope so their costs listed in 7.2.2.2 (\$60k base including M&S + Labor) and 7.3.2.2 (\$202k base including M&S + labor) can be removed from the estimate.
  - The tracking prototype and production LV systems (WBS 7.2.4.2.2, 7.3.4.2.2) appear to be too high. An accurate estimate should be achievable using vendor information and engineering input.
  - There is a double counted procurement of polystyrene and dopants for the scintillator. WBS 1.3.1.2 is essentially a duplicate of the sum of 1.3.1.3 and 1.3.1.4. This accounts for an excess of approximately \$30k.
  - Costs for design reviews such as those listed in 2.1.4, 3.1.11, 4.1.4.5, 5.1.5, 6.1.7, 7.1.6, 8.1.5, and 9.1.5 were zero. The committee feels that while not significant, these costs are non-zero.
- The project's obligation profile exceeds the Directorate guidance profile by \$1.6M in total. Each year 2006-2010 exceeds the Directorate guidance by some amount.
- There is uncertainty about how to correctly apply the 33% overhead factor to Fermilab labor. The project took the most conservative approach by applying it after all other burdening. This obviously has a significant cost impact.
- There is a "management reserve" contingency within Project Management (WBS 10). The project explained that this was to cover the contingency of replacing anticipated uncoded labor with coded labor, e.g. engineers and technicians, and/or for covering an overrun of scoped WBS elements funded by the NSF MRI. The NSF MRI items already include contingency in their WBS elements, so the management reserve is additional contingency. This could require detailed explanation in a DOE review.

- Costs in this review were presented using Microsoft Project. The DOE review will require that COBRA be used for presenting project costs.
- While there may not be a significant cost variance from what the project presented, it is notable that there needs to be a final consensus on the amount of fiber and a more recent vendor quote required for the project prior to CD-3a.

### **Recommendations**

19. Remove \$60k in Labor from 6.3.1.4 through 6.3.1.15.
20. Refine estimates for FE and CROC fabrication.
21. Remove costs and activities for FESBs from the WBS.
22. Develop the BOEs for the tracking prototype and production LV systems using vendor quotes and engineering estimates.
23. Address the double counting of scintillator polystyrene and dopant procurement.
24. Reconcile the project's obligation profile with the Directorate guidance.
25. Adjust the Fermilab labor burdening as more information on its correct application becomes available. The application may vary between Fermilab divisions.
26. Consider whether the management reserve is really the best location for contingency on NSF MRI activities.
27. Prepare costs using COBRA prior to the DOE review.
28. Determine exact amount of fiber required and obtain a new vendor quote prior to the DOE review.
29. Perform some minor cleanup to the BOEs.

## 3.2 Schedule

Primary Writer: Ken Domann

Contributors: Marc Kaducak, Dean Hoffer

### Findings

- The schedule was created and is maintained in Microsoft Project (MPP) and appears to be well developed. Performance data and costs will be maintained in COBRA. Most durations average 15 – 45 days which allows for a good understanding of the scope within each activity. These durations, particularly with respect to procurements, appear to be adequate. This assumes that the up front administrative work associated with procurements is included.
- Of the approximately 1000 tasks, all but 2 have successors. All but 48 tasks have predecessors. There are 65 constraints, one of which is an “As Late As Possible” type constraint. Critical path tasks were identified in the presentations and were consistent with the MPP file available for the reviewers. The tasks that appear on the critical path appear to be appropriate for a project with MINERvA’s physics/engineering requirements. It appears that all activities with float  $\leq$  1 week were listed as critical.
- Most tasks have labor resources, however, there are a number of procurement tasks without any labor assignments. There appear to be some tasks with multiple institution involvement. Labor is currently identified as generic type (no division designation) engineers, technicians, etc. M&S is loaded as both a material type resource (COBRA requirement) and as an entry in the Cost4 user defined field. With respect to labor and M&S, sample “drill downs” in selected WBS elements produced inconsistencies in MPP data vs BOE information.
- The schedule contains approximately 120 milestones, 6 Level 1, 13 Level 2, 33 Level 3, 64 Level 4 and 4 Level 5. There are 17 reviews (design and others) in the schedule.

### Comments

- For approximately 1000 tasks, 65 constraints seems to be excessive, especially the use of the “As Late as Possible” constraint type. This approach can force the activity to assume a zero float position, perhaps eliminating any management flexibility in dealing with subsequent delays downstream of the constrained activity. If possible, allow the activity to occur earlier, allowing for some positive float. A better approach for the other constraints, which are “Start No Earlier Than” types, might be to use milestones to precede these tasks. This can not only provide a constrained start date for a number of tasks, but can also provide descriptive information documenting the need for the constraint. Also, a delay in the milestone eliminates the need to maintain a large number of constraints. At a



minimum, all tasks should have at least one successor (excepting the CD-4 milestone). This insures that more accurate float positions will be calculated.

- The lack of resources on the procurement tasks raises 2 questions. One, are labor requirements underestimated and, two, does the procurement duration allow for the administrative time associated with preparing requisitions, bid cycle (if required) and P.O. award? It was stated that these labor needs were probably in the design or management tasks. However, it would be better to load labor resources against the tasks where the work is performed. This insures that actual costs and related budget are contained in the same cost element. Finally, using standard resource naming conventions (Ex. AD Mechanical Engineer) will help the Lab to better understand resource needs vs availabilities across the various projects. In addition, using these standard names will allow for comparing actual vs planned FTEs. With these exceptions and those noted in the cost section, resource and M&S requirements appear to be adequate for the work scope of each task.
- The MINERvA approach to entering and maintaining M&S information requires manually maintaining the data in 2 separate fields (resource and cost entry). It is understood that interfacing with COBRA requires having the M&S loaded as a resource, however manually maintaining both entries is subject to inconsistencies. Proton Plan uses an approach that automates the creation of this resource value using the MPP Fixed Cost field as the source for the resource entry, ensuring consistency between the two fields.
- The number of milestones appears to be more than adequate, producing on average 2 per month. Numbers and types of reviews also appear to be adequate.

### **Recommendations**

30. Insure that all activities have appropriate logic ties and labor resources. Make each activity unique to an institution.
31. Use milestones in lieu of constraints where possible to reflect constrained dates. Avoid constraints that force a zero float position.
32. Consider adopting the Proton Plan approach for maintaining M&S resource entries.
33. Consider expanding the critical path list to include tasks with float  $\leq$  1 month and monitor this list in sync with your level 2 meetings.

### **3.3 Management**

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#### **Findings**

- The project documentation is well developed for this stage of the project. Project management documents were provided for this review that would be required for CD-2/3A. Documents provided included the Acquisition Plan, Conceptual Design Report, Project Management Plan, Project Execution Plan, Quality Assurance Plan, Technical Design Report, Risk Plan, Project Information Form (NEPA documentation), Preliminary Hazard Analyses, Preliminary Safety Assessment Document, resource-loaded schedule, designs in various stages of completion.
- Several WBS elements are interrelated in their need for delivery of components to various locations for production of the detector and coordination of this is key to successful project completion.
- MINERvA has produced an obligation profile for the project that is supported by a resource-loaded schedule.
- The project has prepared a detailed risk plan, using a software tool that will be used to help manage risks through the project, but the plan does not include WBS 10.
- The recommendations from the December 2006 Director's Review related to Project Management have been addressed.
- The resource FTE graphs presented during the Project Overview plenary presentation was based on 1 FTE was equal to 2080 work hours per year.
- MOU's have been signed with a number of the institutions.
- Monthly reports are being generated.

#### **Comments**

- The project stated that responsibility for coordination of work between WBS items (3, 8, & 9), (5, 6, & 7), and (1, 2, & 4) have been assigned to specific individuals. The project stated that weekly meetings with action items and much documentation, along with small size of group will assure integration and coordination between WBS elements.

- Project obligation profile in the Project Execution Plan, which has not been updated since CD-1 submission, does not match the presented obligation profile.
- The critical path and CD milestones should be shown on the one-page summary schedule, as presented in the plenary session.
- An acting project electrical engineer has been working on the project.

### **Recommendations**

34. Revise the obligation profile to match the Fermilab funding guidance.
35. Complete the Risk Plan to include WBS 10 Project Management. Coordinate allowance for contingency to hire replacement personnel (if required) as an outcome of the PM risk analysis.
36. Update project management documents prior to CD-2/3A DOE review to reflect current baseline information.
37. Complete early procurement bid packages prior to CD-2/3A DOE review.
38. Expand QA Plan to include more information regarding inspection and acceptance processes.
39. Update the Project Management Plan to reflect integration responsibilities described in presentations to the committee, but not yet formally documented.
40. MINERvA needs to use the 85% availability factor in calculating the required FTEs and update the project's resource FTE graphs accordingly. The project is to verify they currently have the required FTEs to execute the project or that there is a plan being implemented to address any shortfall in resources.
41. A project electrical engineer should be identified and assigned as soon as possible.

## **4.0 Charge Questions**

### **Technical**

#### **4.1 Are the technical specifications clearly stated and documented?**

The technical specifications are clearly stated for all subsystems. In most cases they are well documented, either within the TDR or elsewhere in the MINERvA document database (docdb).

#### **4.2 Can the design be built? Does the design meet the technical specifications? Is it a reasonable design?**

The design is based on proven technologies that have been used by a number of current and future experiments. Preliminary measurements suggest that it should meet its technical specifications. Within the budget and schedule, the design is reasonable and can be built.

#### **4.3 Does the baseline design meet the project's objectives (mission need)?**

The combination of the inner and outer detectors should allow the collaboration to separate muons, pions and protons and reconstruct interaction vertex. The muon momentum and hadronic energy resolutions appear to be sufficient to meet the physics requirements. Yes, the baseline design, if built within specifications, should meet the requirement for studying low-energy neutrino interactions.

#### **4.4 Is the Work Breakdown Structure (WBS) appropriate for the project scope?**

Yes, the WBS is comprehensive and well organized.

#### **4.5 Do the cost estimates for each WBS (or cost) element have a sound documented basis and are they reasonable?**

Besides a few exceptions noted in section 3.1 of this report, the WBS elements had sound basis of estimate that were prepared systematically. These BOEs were available for review both in paper binders and electronically in the DocDB.

#### **4.6 Does an obligation profile exist and is it within the funding guidance profile?**

As noted in section 3.1 of this report, there is a basic discrepancy between the obligation profile and the guidance in that the total project cost is \$1.6M higher in the project's profile than in the guidance profile. The committee has recommended that this be reconciled.

#### **4.7 Is the schedule well developed and appropriately structured by specifying relationships, predecessors, successors, critical path, resource loaded, etc?**

The schedule is well developed. With some relatively minor exceptions, all activities have successors, predecessors and resources. The critical path in the schedule was consistent with the one presented by the project team.

**4.8 Are the durations for the activities and overall schedule reasonable and achievable with the assumed resources?**

Durations and resources appear to be adequate for the work scope identified. Some minor concerns with procurement tasks.

**4.9 Does the schedule contain appropriate levels of milestones, sufficient quantity of milestones for tracking progress and do they appear to be achievable?**

The schedule contains approximately 2 milestones per month at different levels which appear to be achievable within the overall schedule.

**4.10 Does the schedule include activities for design reviews, which include assessment of the designs readiness for procuring prototypes, preproduction and production materials?**

There are 17 reviews in the schedule, which appear cover all of the key design efforts.

**4.11 Is there an appropriate management organizational structure in place to accomplish the design and construction?**

The organization is in place to accomplish the design and construction, and individuals have been identified and assigned to the project, especially in key positions.

**4.12 Is the organization structure well documented with responsibilities defined and appropriate for the scope of work?**

The project management structure is documented and responsibilities are written into the Project Management Plan. One exception is responsibility for integration of tasks between WBS elements, which was discussed and individuals identified, but this is not documented.

**4.13 Are there adequate staffing resources available or planned for this effort?**

Staffing resources are being drawn from Fermilab and from universities. These resources are identified in the Cost and Schedule Plan, and appear to be adequate for the project.

**4.14 Is there a funding plan available or proposed to meet the resource requirements to realize the project?**

An obligation plan has been proposed which comes from the resource-loaded schedule. The plan does not match the guidance from the Fermilab directorate for funding. Plans to match the project's proposed obligations to the funding profile were discussed and need to be further discussed with Fermilab management.

**4.15 Has a Risk Plan been developed, risks identified, risks analyzed, risks responses planned/implemented, risk monitoring/control process established and do they seem appropriate?**

A Risk Plan has been developed using WelcomRisk. Still missing from this is the project management risks. Top risks have had mitigations developed and translated to cost and schedule contingencies. PM plans to use this tool to continue to evaluate risks as the project progresses. The process seems to be appropriate for this project.

**4.16 Have the critical procurements been identified and are they included in the schedule with adequate lead time built in?**

Yes, critical long lead procurements (LLP) have been identified and included in the schedule, but no schedule contingency has been built into the lead time to start the procurement process in order to mitigate potential use of the contingency for CD-4.

**4.17 Have critical make vs. buy decisions been evaluated in conjunction with the scope and is that reflected in the baseline cost estimate, schedule and technical risk plan?**

For the long lead procurements a make vs. buy decision was not required because the materials needed are always a buy decision. Make vs. buy decisions have been made for other parts of the project, which appear to be appropriate.

**4.18 Are the designs final and procurement packages prepared to the degree appropriate to initiate construction as scheduled?**

No, The designs for the long lead procurements are close to final, but no procurement packages have been prepared for the long lead procurements and available for review. The designs needs to be finalized for the long lead procurements and procurement packages prepared prior to the DOE CD-2/3a Review.